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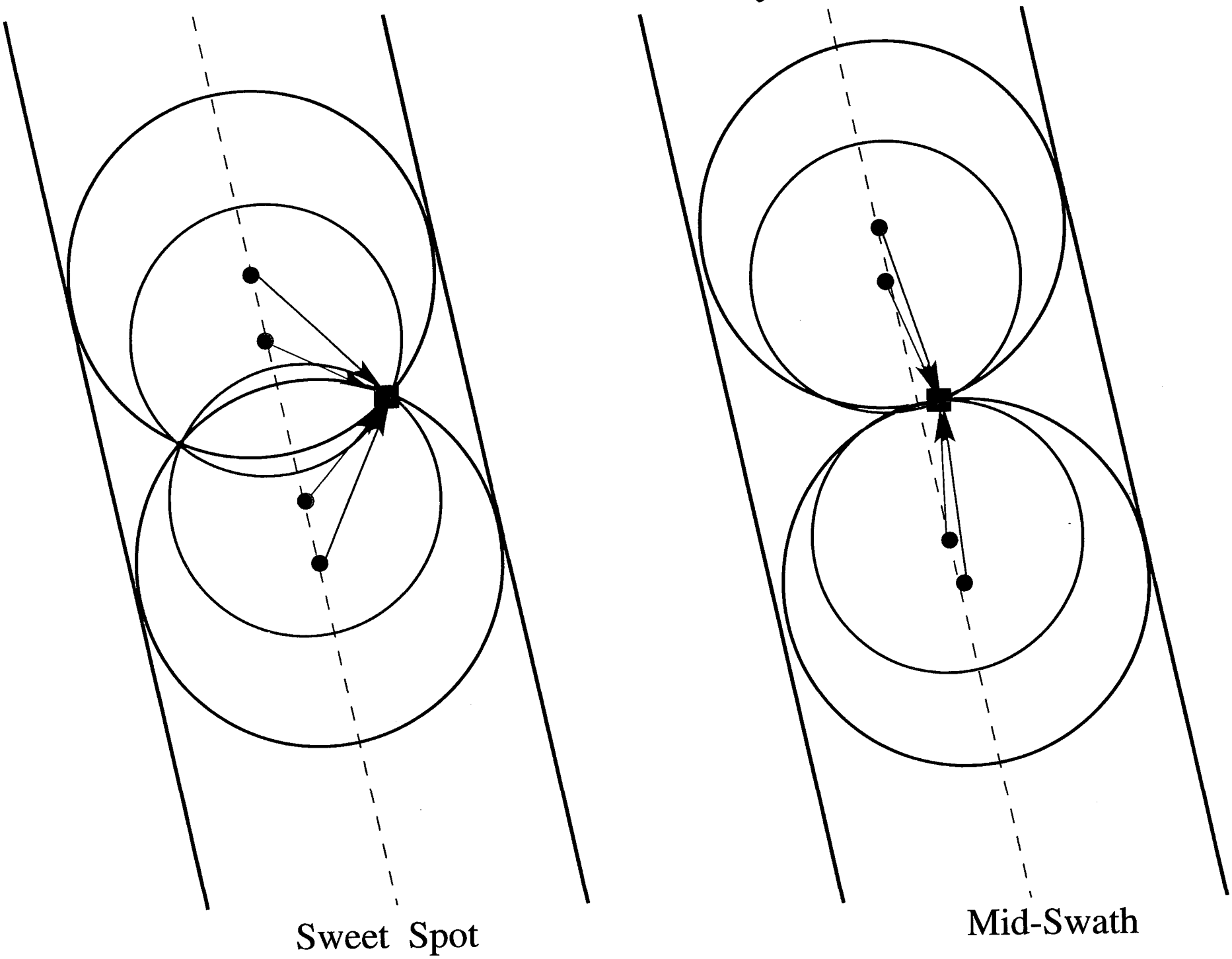
Abstract

The SeaWinds on QuikSCAT scatterometer was developed by NASA JPL to measure the speed and direction of ocean surface winds. Simulations performed to estimate the performance of the instrument prior to its launch have indicated that the mid-swath accuracy is worse than that of the rest of the swath. This behavior is a general characteristic of scanning pencil beam scatterometers. For SeaWinds, the accuracy of the rest of the swath, and the size of the swath are such that the instrument meets its science requirements despite mid-swath shortcomings. However, by understanding the problem at mid-swath, we can improve the performance there as well. We discuss the underlying causes of the problem in detail and propose a new wind retrieval algorithm which improves mid-swath performance. The directional discrimination ability of the instrument varies with cross track distance, wind speed, and direction. By estimating the range of likely wind directions for each measurement cell, one can optimally apply information from neighboring cells where necessary in order to reduce random wind direction errors without significantly degrading the resolution of the resultant wind field. In this manner we are able to achieve mid-swath RMS wind direction errors as low as 15 degrees for low winds and 10 degrees for moderate to high winds, while at the same time preserving high resolution structures such as cyclones and fronts.

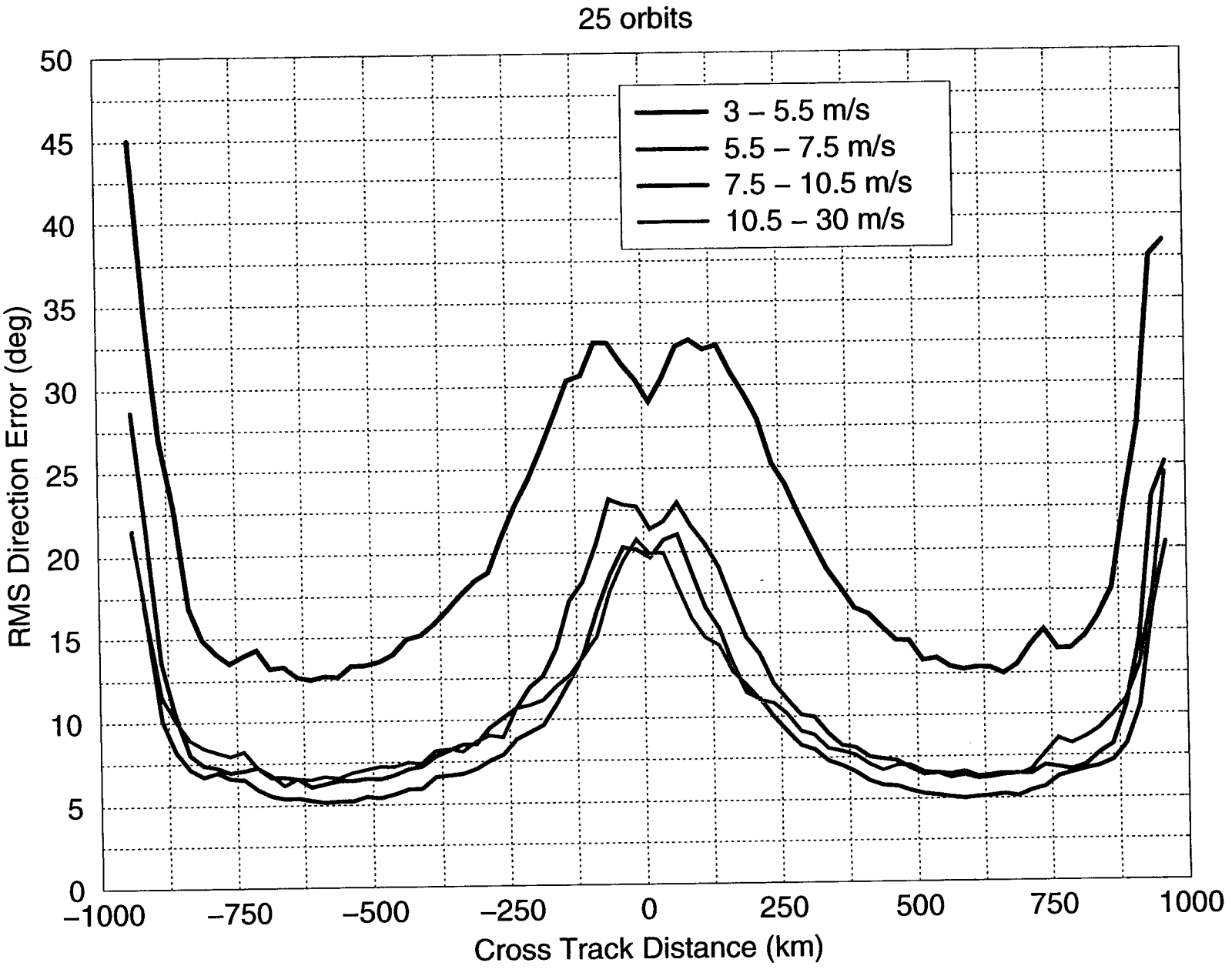
Measurement Geometry



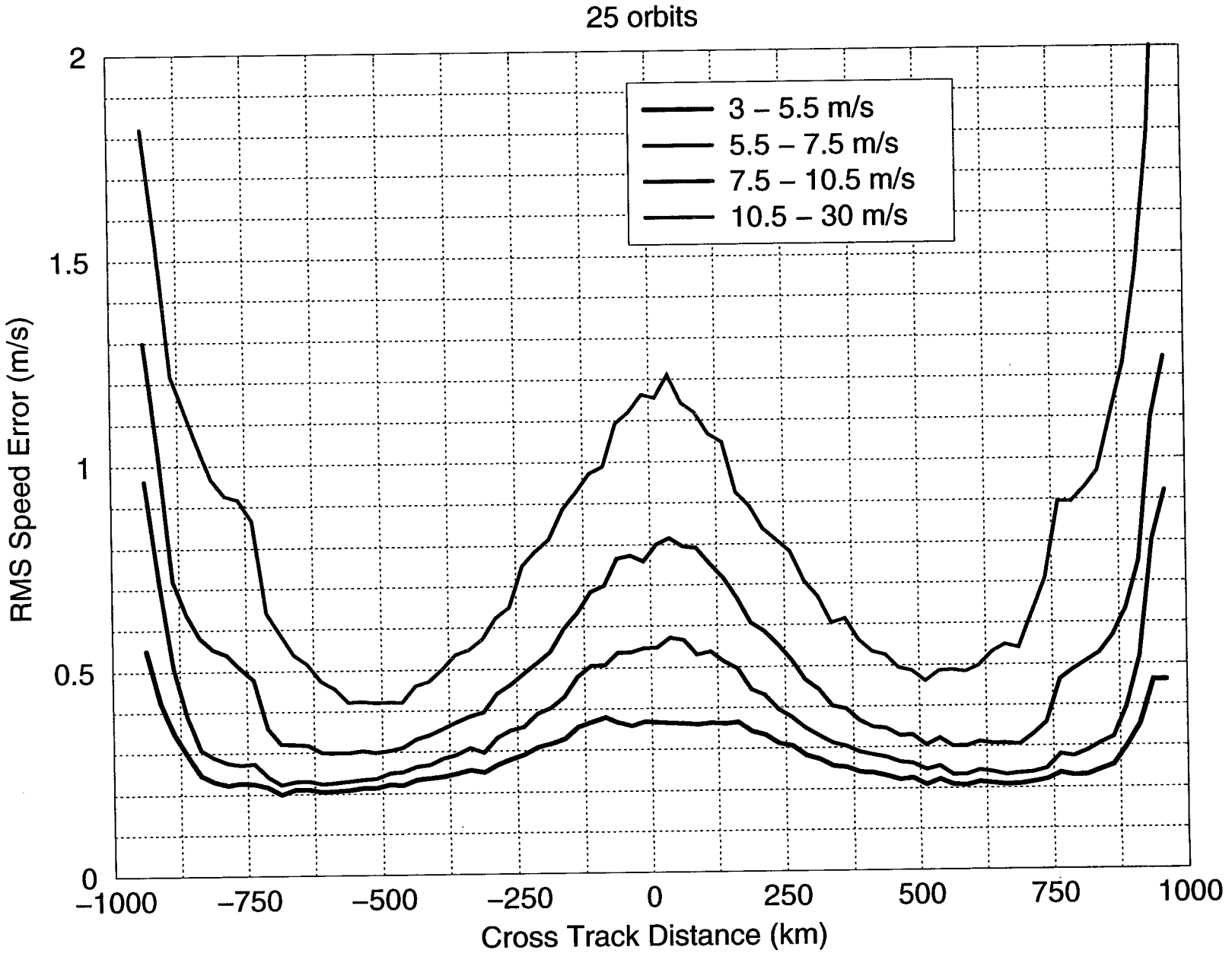
Standard Wind Retrieval Algorithm

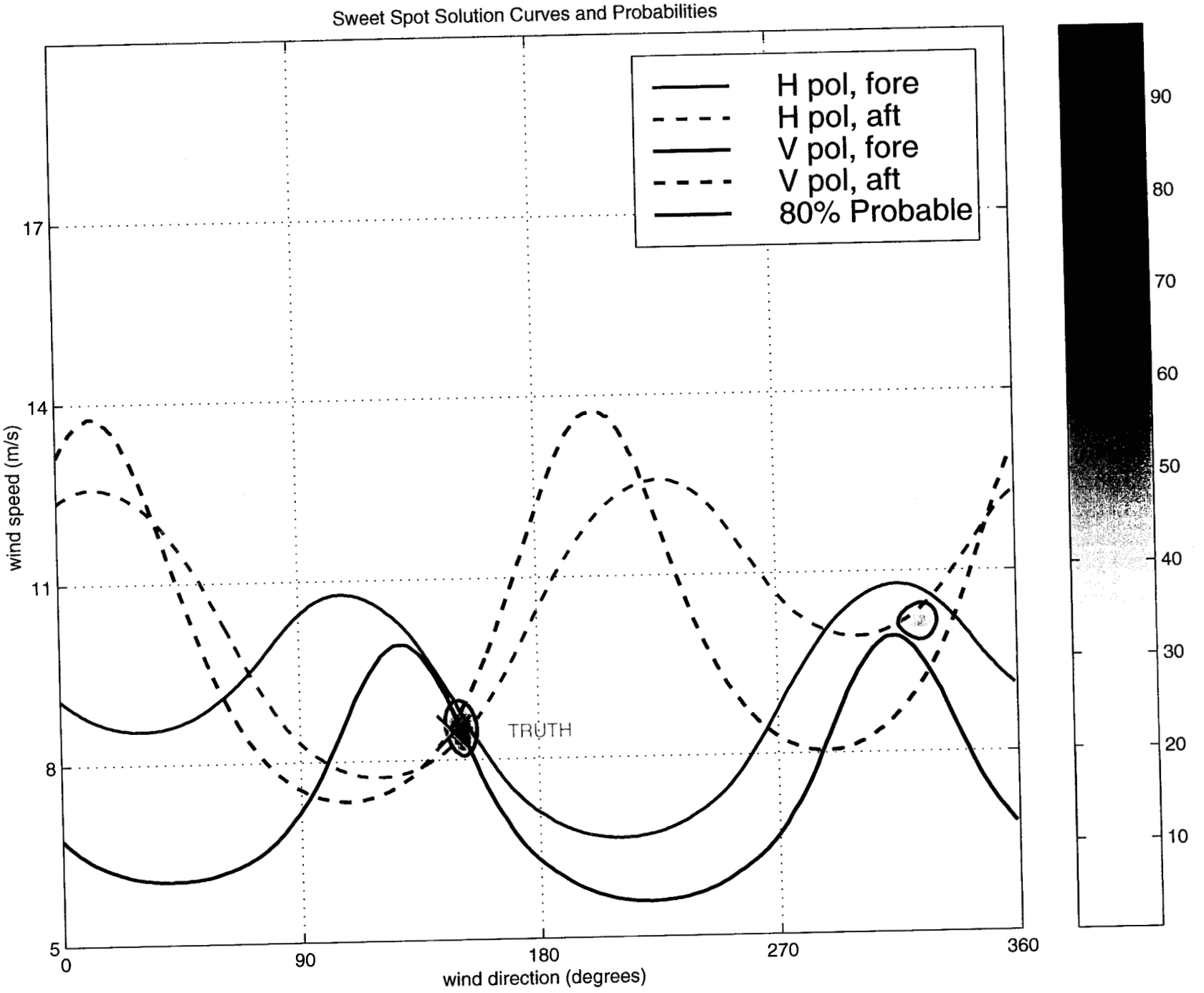
- pointwise wind retrieval
  - maximum likelihood estimator
  - multiple peaks in objective function
- ambiguity removal
  - initialization using an external model ("nudge") wind field
  - multi-pass median filtering

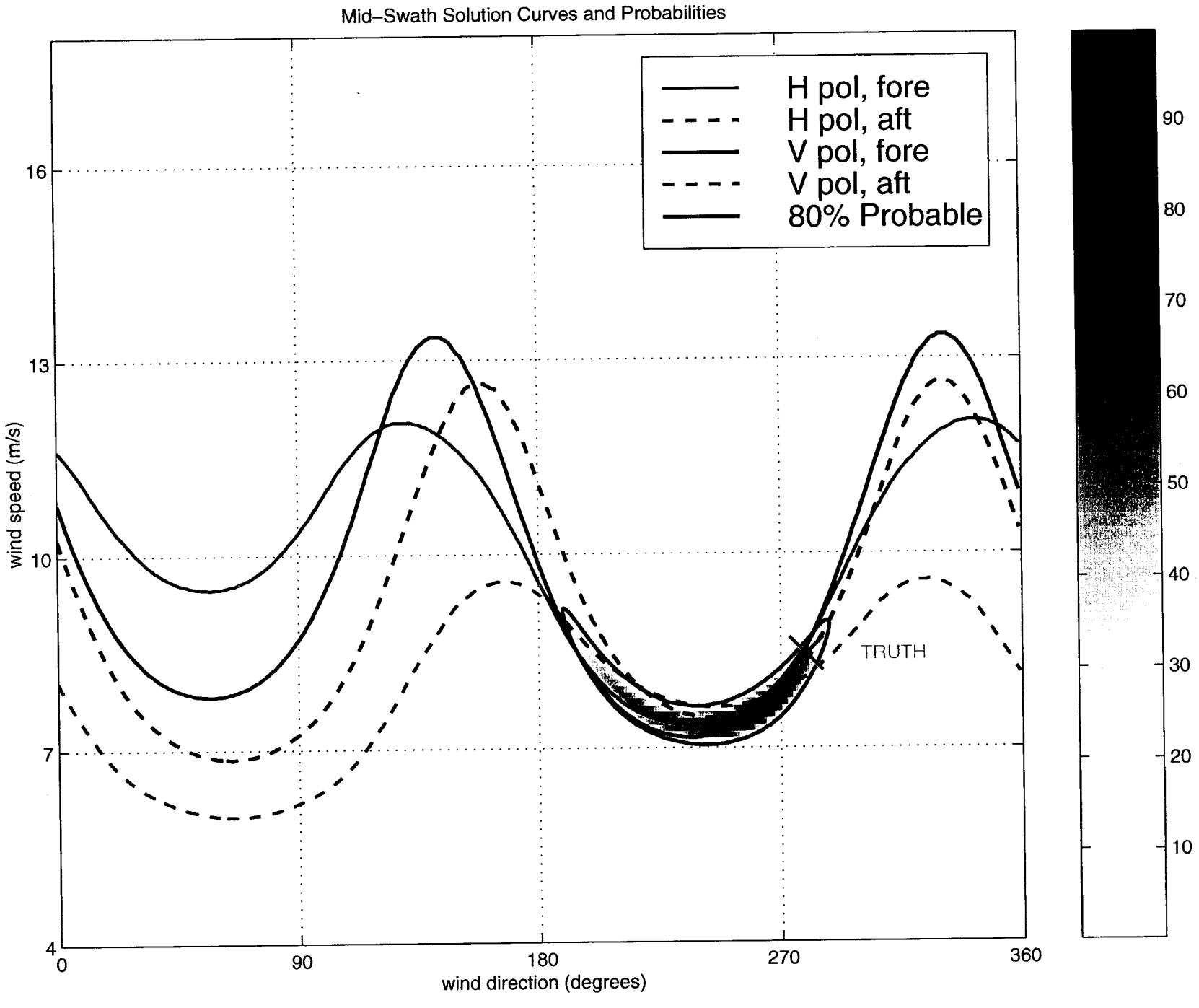
Baseline Nearest RMS Direction Error



Baseline Nearest RMS Speed Error




Sweet Spot Solution Curves and Probabilities
H pol, fore
H pol, aft
V pol, fore
V pol, aft
80% Probable
TRUTH
wind speed (m/s)
wind direction (degrees)
5
8
11
14
17
0
90
180
270
360
10
20
30
40
50
60
70
80
90

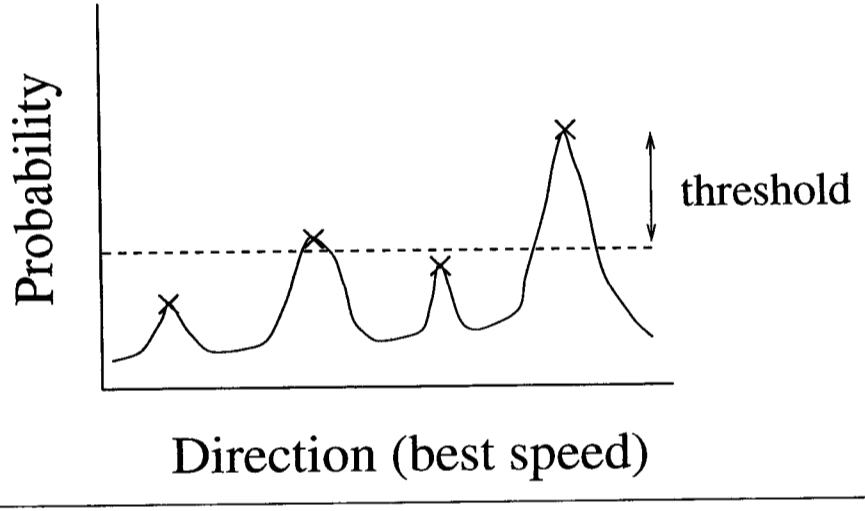

Mid–Swath Solution Curves and Probabilities
H pol, fore
H pol, aft
V pol, fore
V pol, aft
80% Probable
TRUTH
wind speed (m/s)
wind direction (degrees)
16
13
10
7
4
0
90
180
270
360
90
80
70
60
50
40
30
20
10

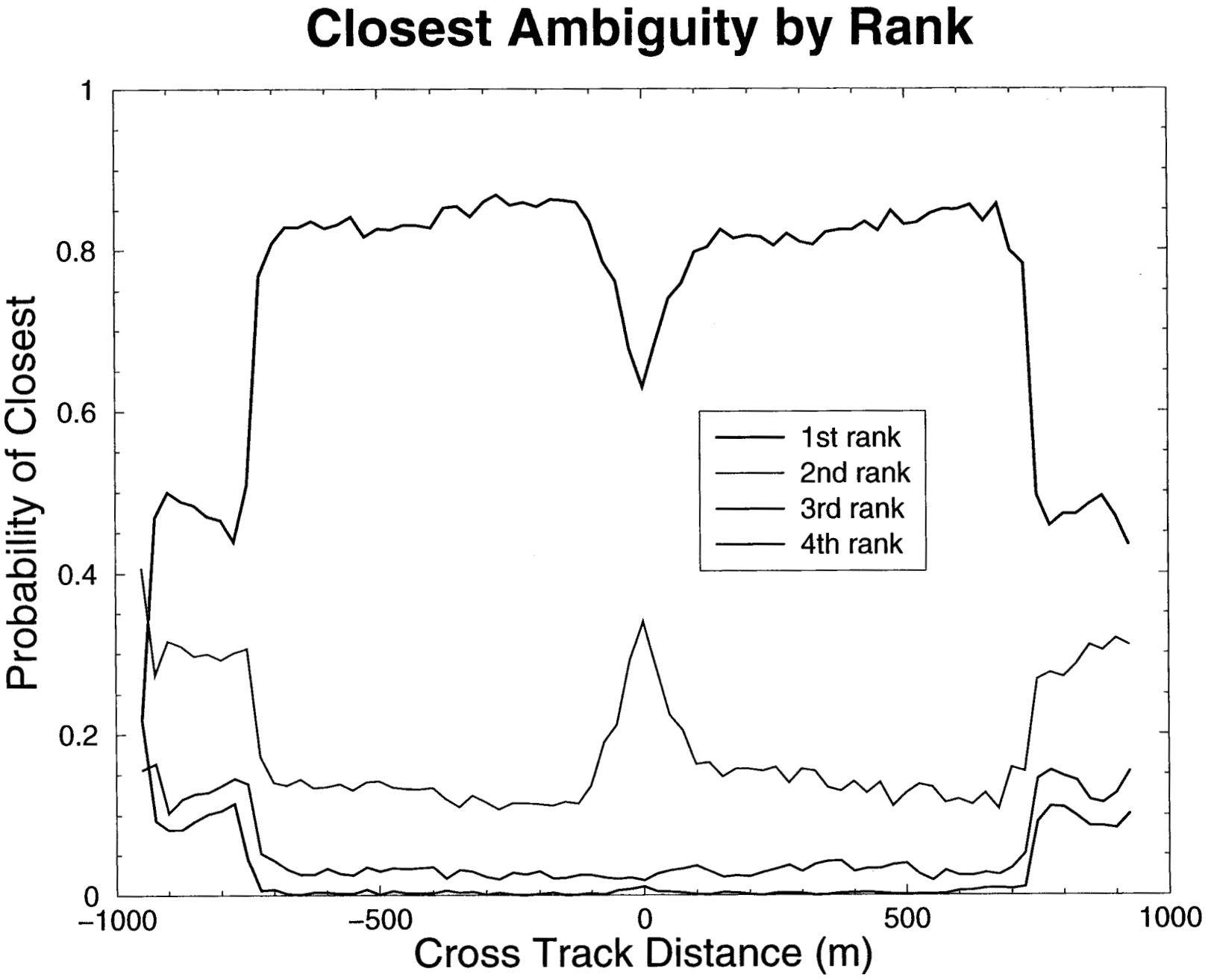
Mid-Swath Enhancement Technique

- pointwise wind retrieval
  - estimate 80 percent error bounds on retrieved ambiguities
- ambiguity removal
  - first stage: select best ambiguity
  - second stage: select best direction within the error bounds for that ambiguity

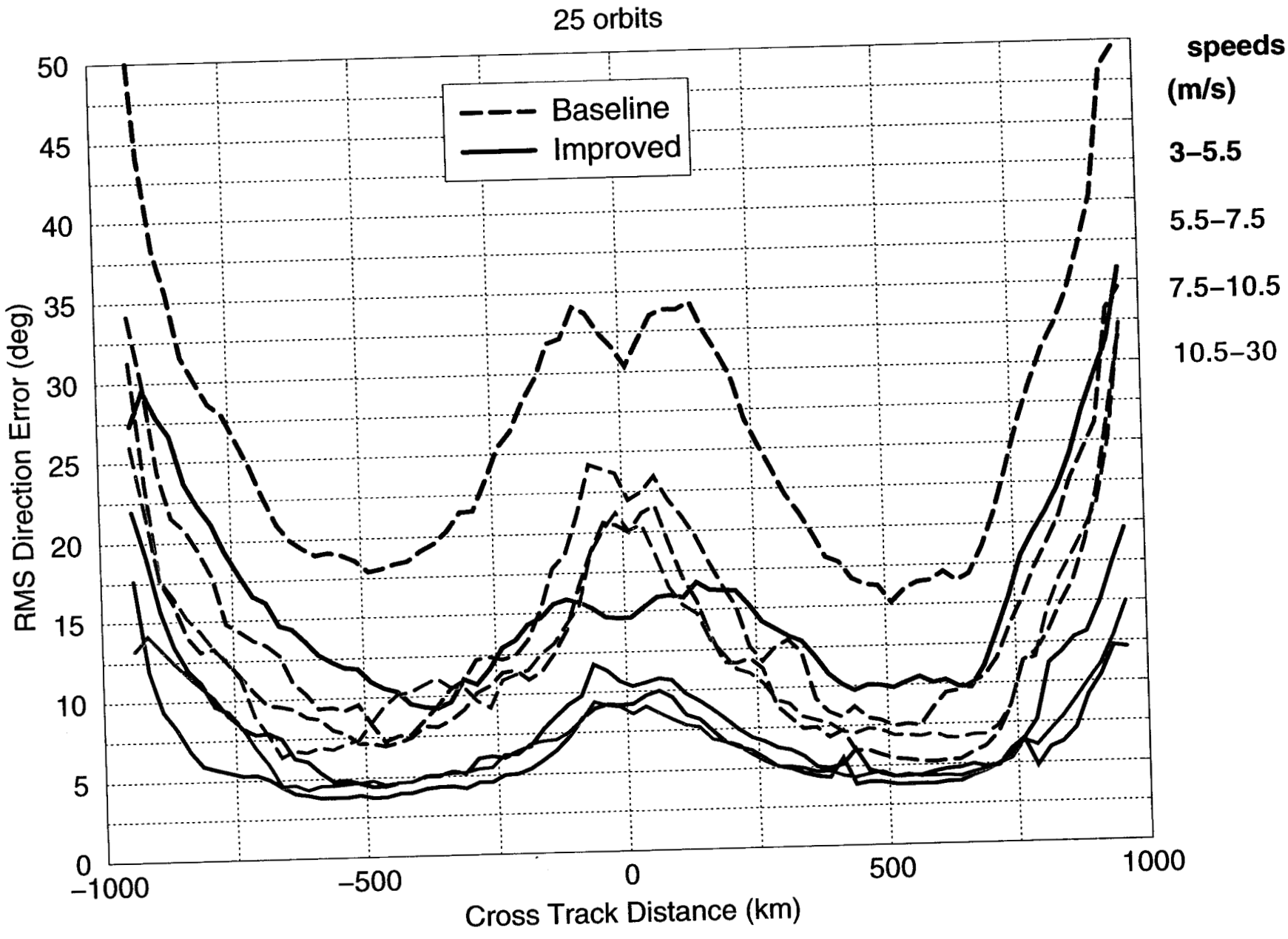
Far-Swath Enhancement Technique

- baseline wind retrieval:
  - locate up to four ambiguities
  - initialize the median filter with the closest of the top two ambiguities to the model field
  - median filter
- thresholded wind retrieval:
  - limit the number of ambiguities available for initialization based on a threshold value

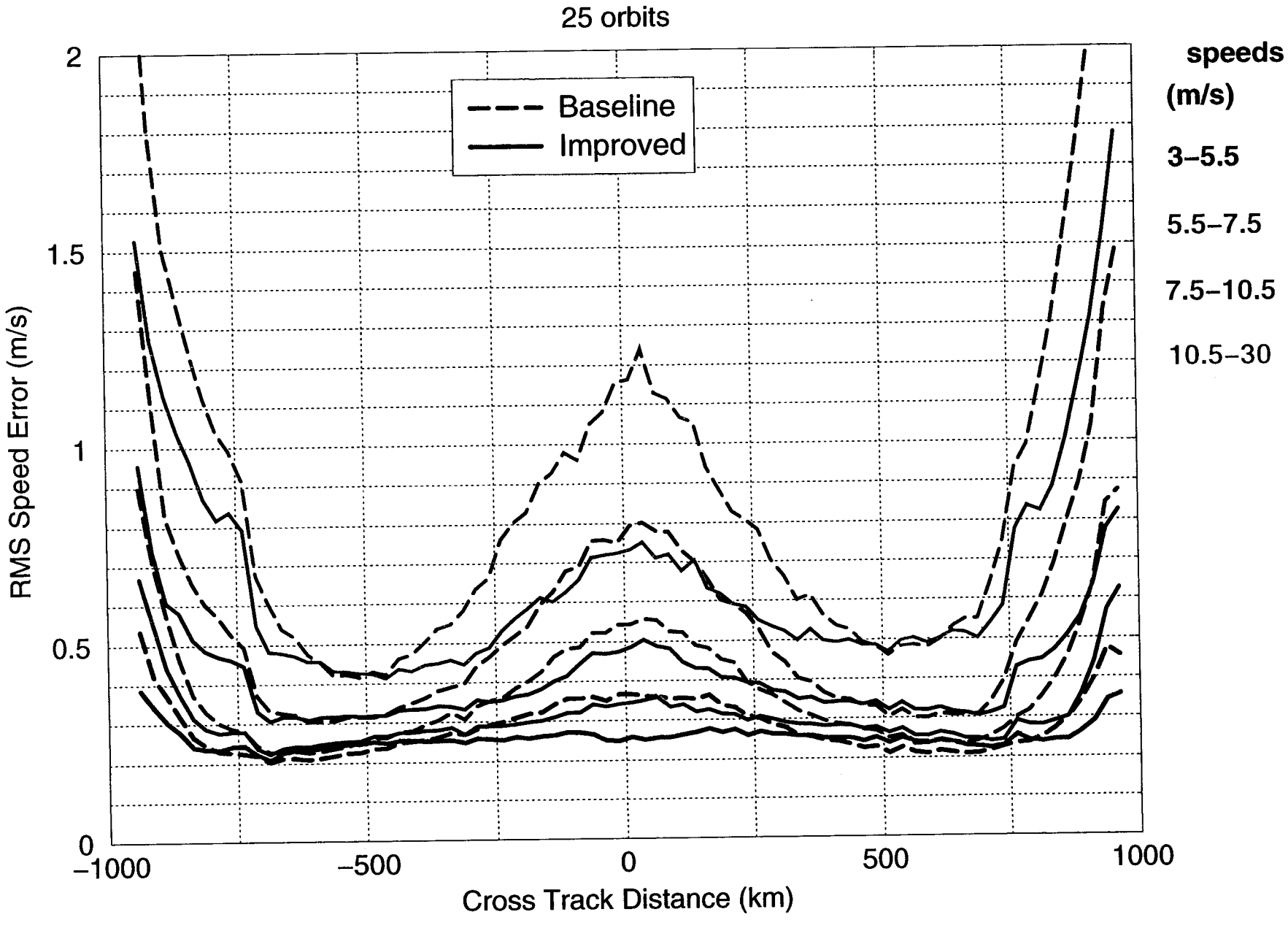



Closest Ambiguity by Rank
Probability of Closest
1
0.8
0.6
0.4
0.2
0
−1000
−500
0
500
1000
Cross Track Distance (m)
1st rank
2nd rank
3rd rank
4th rank

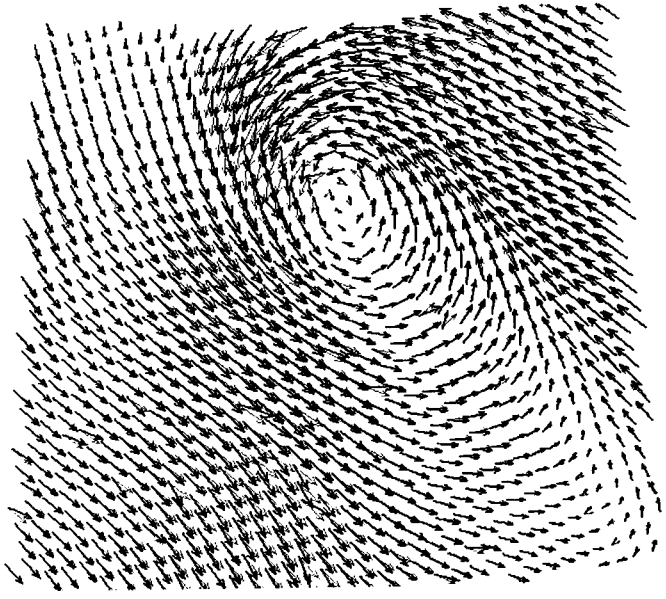
Comparison of Selected RMS Direction Error



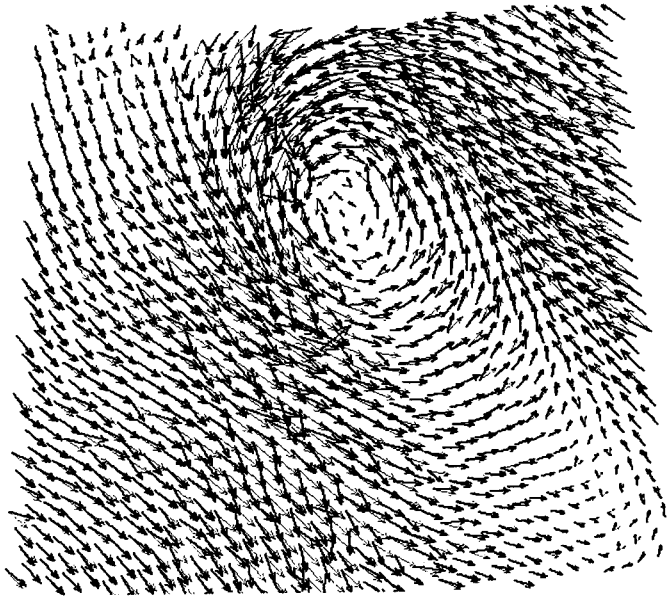
Comparison of Selected RMS Speed Error



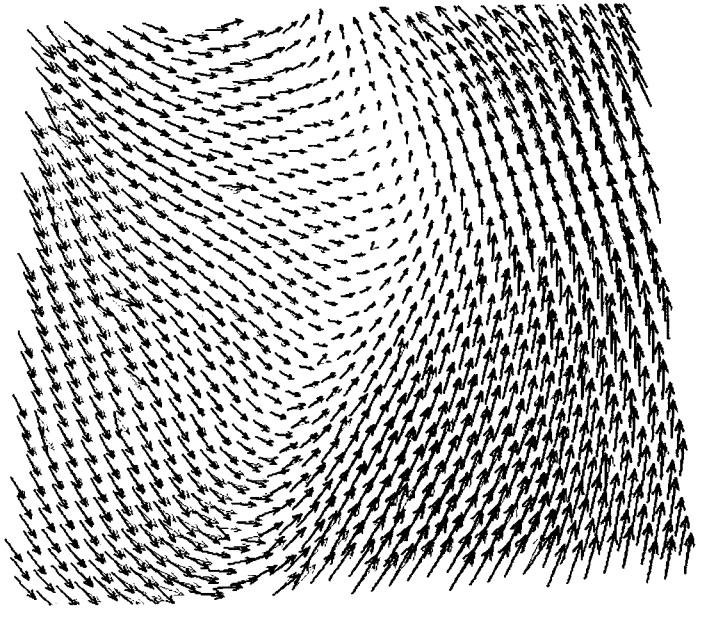
Example Wind Fields



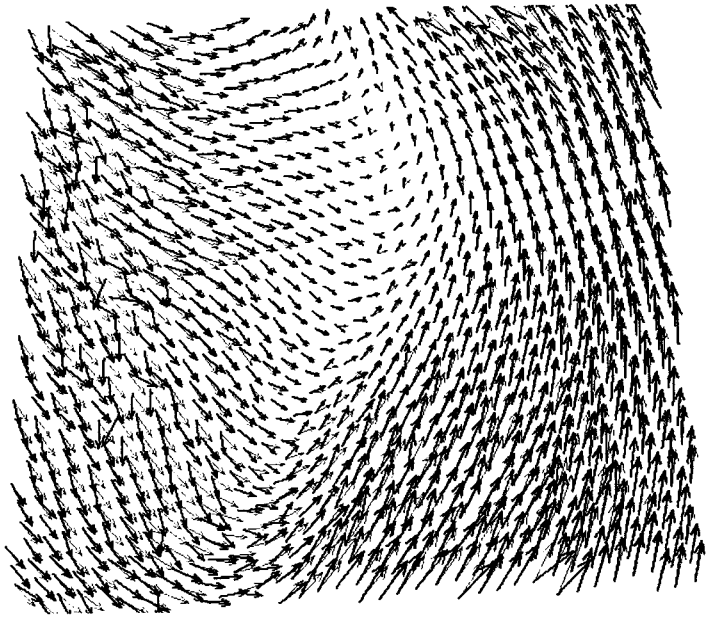
Wind field 1, Improved



Wind field 1, Baseline



Wind field 2, Improved



Wind field 2, Baseline